A SUMMARY OF THE GEOLOGIC HISTORY OF LIBYA

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Libya, situated along the northern coast of Africa, lies roughly between 20° and 32°N and between 10° and 25°E and covers an area of approximately 1,750,000 square kilometers. Libya, interior Algeria, and the western desert of Egypt are on the northern fringe of the African shield and extend over a stable platform area of cratonic basins. These cratonic basins contain thick sequences of moderately deformed Paleozoic rocks and, with the exception of the basins in north west Libya, a comparatively thin sequence of Mesozoic sedimentary rocks. That these basins were active as recently as Tertiary time is evidenced by the presence of thick Tertiary rocks in Sirtica and northern Cyrenaica.

PRECAMBRIAN: Precambrian crystalline rocks occur in south and southeastern Libya in the areas of the Tibesti mountains, Jebel Archenu and Jebel Auenat. These rocks are metamorphic series composed of para and orthogneiss, quartzite, and marble all intruded by granitic rocks. Desio and Gallitelle regard the metamorphic series of Jebel Archenu and Jebel Auenat as Archean in age and consider the granite to be younger and possibly contemporaneous with the Hercynian folding at the close of the Carboniferous. The intrusive rocks are muscovite and biotite granites that are cut by aplitic and pegmatitic dikes. Other exposures of Precambrian rocks occur in south-central and west-central Libya at Jebel Eghei and Jebel Fezzan, where the overlying sediments have been removed. These rocks are believed to be part of the basement complex and are considered to be comparable to Pharusian.

PALEOZOIC: Paleozoic rocks are exposed in Fezzan province and in southern Cyrenaica. In Fezzan the Paleozoic section grades eastward from a marine to a mixed marine-continental sequence and finally into a facies that is predominantly continental. The Paleozoic rocks of southern Cyrenaica are

made up of continental complexes.

The geologic structure of the Fezzan province can be easily integrated within the general structure of North Africa. The main structural feature is the Murzuk basin which lies between the broad arches of the African shield of the Ahaggar and the Tibesti areas. The basin is delimited on the north by the Gargaf Arch, a major structural feature with an east-west trend. On the west, north of Ahaggar area the basin sediments are warped upward to form the Edjeleh anticline. This structure trends north-south roughly along the Algerian-Libyan border and separates the Murzuk basin from its Western extension, the Polignac basin.

CAMBRIAN-ORDOVICIAN: Unconformably overlying the basement complex is a series of sandstones and conglomerate beds which extend over a large area of southern Cyrenaica and the Fezzan province. These beds are exposed on the periphery of the Murzuk basin, in the Tibesti area and in the Jebel Eghei and southeastern areas of Cyrenaica where they are characterized by a basal conglomerate composed of quartz pabbles and cobbles. The clastic sediments forming these rocks were probably deposited before the (Silurian) Tassillian transgression that followed pre-Tassillian penaplanation which was general through-out the area of the African Sahara from Atlantic to the Red Sea.

Desio mapped and termed the continental sequence in eastern Fezzan and southern Cyrenaica as Mesozoic and Paleozoic Nubian. The author considers the continental sandstone beds overlying the basement at Jebel Auenat, Jebel Fezzan and in the Tibesti area as more restricted in time, possibly only Cambrian and Ordovician or Early Silurian. The younger continental sandstones are considered to be Late Cretaceous in age.

SILURIAN: An early Silurian transgression is marked by shallow water marine beds including a basal conglomerate. It has been suggested by Lelubre that the Caledonian disturbance created deep sea conditions during Gothlandian time and that during this time thick layers of marine sediments including graptolitic muds were deposited. On the basis of known rock exposures, the Silurian seas are known to have extended as far south as 23°N near the In-Ezzane area and as far as 13°E at Edri, in north-central Fezzan province.

Regression of the seas at the end of the Silurian period is marked by a littoral facies in the Murzuk basin. These beds grade eastwardly into a continental deposit in

the Tibesti region.

DEVONIAN: Renewed marine transgression occurred during Devonian time. During this period the Tihemboka anticlinal area became emergent which resulted in creation of two marine basins.

Upper Devonian rocks are well exposed near Auenat-Uennin north of the Gargaf Arch, but south of the anticline, beds produced during marine regression are present.

CARBONIFEROUS: (Dinantian). Transgression of the seas south of the Gargaf antieline took place in late Devonian or at the beginning of the Carboniferous, but by the end of Visean time the emergence of land and regression of the sea to the north gave rise to the deposition of continental sandstone beds which became general during Namurian time.

MESOZOIC: Continental intercalaire: a continental environment prevailed in the Fezzan and south east Libya after the Carboniferous and continued possibly until middle Cretaceous time. These predominantly arenaceous deposits are covered by marine beds of Cretaceous age near Auenat-Uennin but are well exposed to the south deeper within the Murzuk basin. In the Murzuk basin the deposits cover a large area and lie discordantly on Paleozoic sediments. It is probable that all of the Silurian andpart of the Devonian rocks wedge out to the east.

A marginal trough that extended through northwestern Libya and southern Tunisia during Mesozoic time resulted in the deposition of an almost complete sequence of Mesozoic rocks at the present site of Jebel Nefusa (Garian-Jefren escarpment) in Tripolitania.

These Mesozoic formations were deformed in a vast anticlinal swelling that trends northwest-southeast and reaches its highest point west of the Garian area. Along the axis of the fold are numerous igneous masses made up of extrusive basalts and intrusive phonolites. The alignment of these rocks with the tectonic axis suggests that they are related to a deep-seated phase of the orogeny. A system of north-south valleys is imposed normal to the trend of the structure. The emergence of the land at the end of the Cretaceous time is probably the cause of the numerous faults that parallel the anticlinal axis.

Triassic rocks representing marine transgressive series

of the Alpine type are present in Tripolitania and are composed principally of gray to dark-gray limestones with subsidiary shales. The upper part of this series is composed of anhydrite, shale and dolomitic limestone. In Fezzan province a part of the post-Tassillian beds is considered to be of Triassic age.

Rocks of Liassic (Jurassic) age are exposed only in Tripolitania. They are represented by massive beds of gypsum and anhydrite interbedded with subsidiary dolomitic limestone and shale units grading into dolomitic limestone. It is suggested that continental and lagoonal conditions alternated with a shallow marine environment during the period.

The entire sequence of Cretaceous rocks from Wealdian to Danian are present in the Tripolitanian Jebel. Rocks of Wealdian-Albian age are predominantly soft, pale-yellowish claystone and marl interbedded with pure gypsum and red and gray crossbedded conglomeratic sandstone. They are thought to be of continental origin. The Cenomanian is represented by interbedded dolomitic limestone and marl with some gypsiferous beds.

A marine transgression in Senonian time that extended deep into the platform below the 29th parallel produced a series of limestone and vari-colored shale beds with some interbedded dolomitic limestone and gypsum. The upper part (Danian) is represented by massive crystalline limestone with interbedded claystone and gypsum. Near the end of Cretaceous time movements and deformation occurred warping the platform. Emergence of the beds and subsequent erosion produced breaks within the Cretaceous section.

One of the effects of these movements was the formation of a north-south trending trough, a graben, that extends from the area of Bu Ngem to near Hun and separates the Upper Cretaceous formations of Tripolitania from the Tertiary sediments of Sirtica.

TERTIARY: None of the older Tertiary rocks are exposed in western Tripolitania, but Miocene sediments deposited in a transgressive seas occur for a distance of about 30 kilometers south of the present shore line. These Miocene sediments are represented by thick claystone beds which are directly overlain by the Pleistocene deposits of the coastal plains. A progressive decrease in the thickness of the Miocene rocks to the south has been noted in drill records. Eocene sediments were deposited in seas that invaded Libya in Sirte area at least as far south as 23°N near the Tibesti

where Eocene beds are found on crystalline basement rocks. North, toward the coast, progressively younger Tertiary sediments of Oligocene and Miocene age crop out. Middle Miocene sediments are exposed on the coast line of the present Gulf of Sirte. The Tertiary sedimentary rocks include fossiliferous limestones, calcareous sandstones, marls and argillaceous beds. Tertiary marine sedimentary rocks of Eocene, Oligocene and Miocene ages ages occur in northeast Libya (Cyrenaica) and include the greater part of the rocks exposed there. The Eocene is represented by cherty Echinoidal and Nummulitic limestone beds. The Oligocene consists of a shallower marine sequence than that of Eocene age and is conformable on the Eocene to the north in the area of Tolmeta; to the south near El Abid the Oligocene appears to be transgressive on Cretaceous rocks. The Miocene in Cyrenaica is represented by yellow, gray and greenish-gray limestone, coarse yellowish and white limestone and sandy limestone on top. Perfect conformity exists between Oligocene and Miocene beds in northeastern part of Cyrenaica but to the north-west the Miocene rests directly on the Eocene.

Orogenic movements beginning in Oligocene time continued into late Miocene resulting in some warping.

VOLCANISM: The volcanic massifs of Jebel es Soda and Jebel Harug are outstanding features of the Libyan desert. These elevated masses of basalts together with other extrusive rocks cover an area of more than 35,000 square kilometers.

Volcanic activity in the eastern and northern parts of the Fezzan province occurred after the Eocene regression, although the volcanic cones at Wau el Namus and north of Jebel Harug are believed to be very recent.

In general the volcanic activities in Libya are believed to have been concurrent with movements along deep-seated fractures pehaps in connection with the great orogenic pulse of the Alpine cycle.

QUATERNARY: The Quaternary rocks in northern part Libya are principally continental deposits, but there was one large marine incursion during the Tirrehenian stage.

The Quaternary deposits of the interior consist principally of sand. Giant sand dunes of southwestern Libya cover approximately 145,000 square kilometers and an even larger area in the eastern desert. The dune areas seem on the whole to be fixed in position.

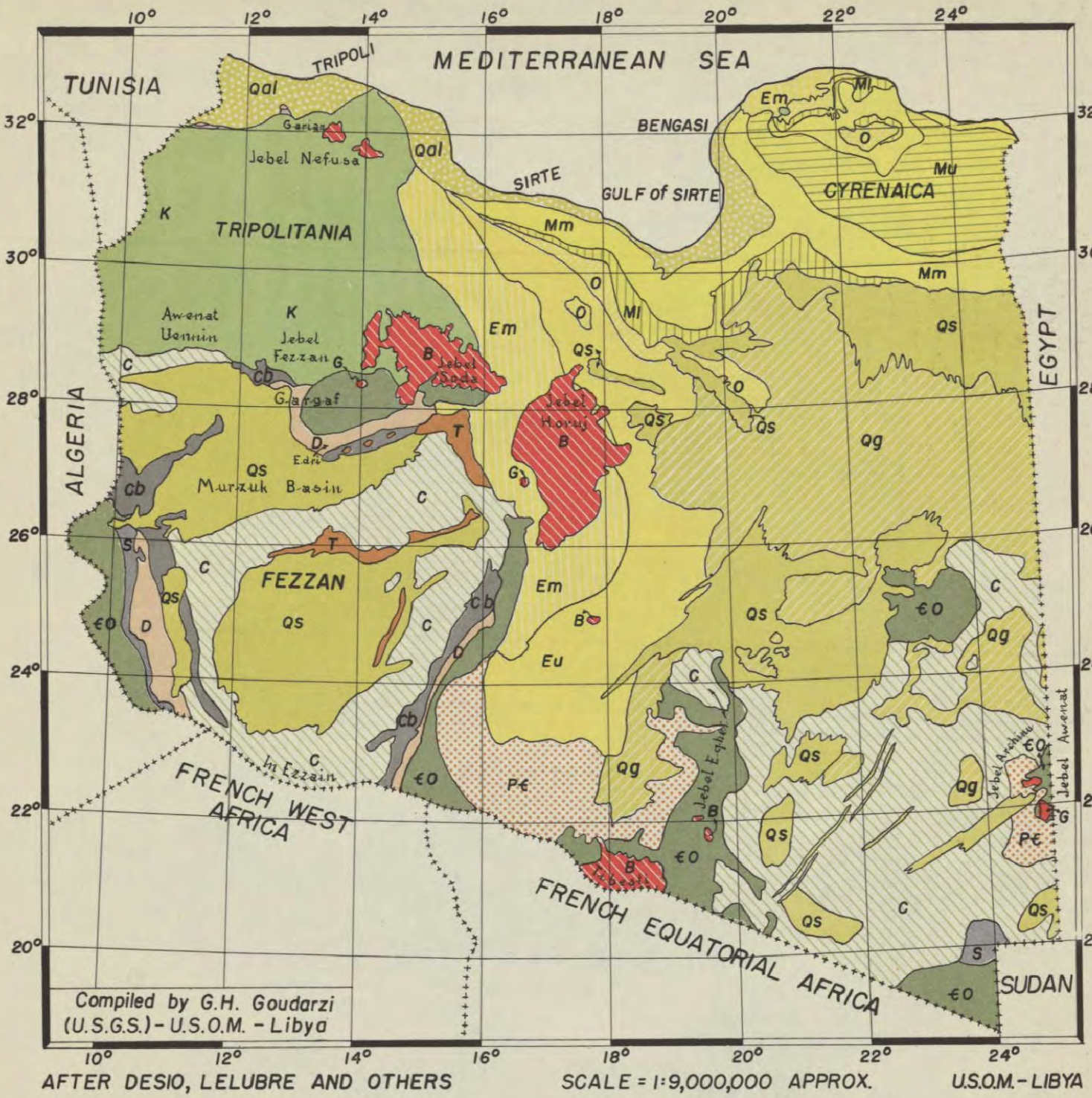
sand
The deserts of Libya are in broad basins of tectonic

origin and are regions of interior drainage. The relief of the Libyan deserts is due in part to irregularities of the surface beneath the sand; the Libyan Sahara is intimately linked with the occurrence of basined land and it is safe to assume the pre-existence of wide depressed areas rimmed by mountain barriers. Within these broad basins occur local elevations of considerable height and extent and numerous lesser basins of various altitudes.

The desert sands are principally fine-grained quartz with a characteristic eolian polish effect. The quartz grains are generally coated with iron-oxide which gives them a yellowish or reddish color. Associated minerals include orthoclase, glauconite, magnetite, epidote and mica.

Gravel covered plains are also characteristic of the greater part of the Libyan desert and are known as Serirs. In these regions the surface of the undissected land is covered by both angular and rounded pebbles and are believed to have been formed by the disintegration, in place, of local rocks by weathering.

GEOLOGIC MAP OF LIBYA



AFTER DESIO, LELUBRE AND OTHERS — SCALE = 1:9,000,000 APPROX. — U.S.O.M. - LIBYA

TERTIARY QUATERNARY
- Qs Dune area
- Qg Gravel plains
- Qal Alluvium
- Mu Upper — Miocene
- Mm Middle — Miocene
- Ml Lower — Miocene
- T Continental — Tertiary

MESOZOIC TERTIARY
- O Oligocene
- Eu Upper — Eocene
- Em Middle — Eocene
- K Cretaceous
- C Continental Intercalaire
- JR Liassic — Jurassic
- R Triassic

PALEOZOIC
- Cb Carboniferous
- D Devonian
- S Silurian
- €O Cambrian — Ordovician

PRE-CAMBRIAN
- B Tertiary — Igneous
- G Granite
- P€ Metamorphic rocks